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Nature Study Course

For Graded Schools

Edited by H. L. ATWOOD

UNIVERSITY OF ILLINOIS
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PRESIDENT'S OFFICE

Bulletin of the
Missouri State Normal School
Third District

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INTRODUCTION

Probably no other subject which has received the approval of educators, and which offers such attraction to the student, has been so slow to find entrance into the school curriculum as Nature Study. Although courses of study provide for it, and many books have been written about it, the fact remains that in a large majority of the schools no Nature Study work is attempted, or if attempted, is but poorly done. It is no criticism of the teachers to say that the reason for this is because they themselves do not know what to do. The thorough preparation of teachers can come only with time. Undoubtedly the best preparation consists in a knowledge of the natural sciences, but it does not follow that excellent results may not be obtained where teachers have had no opportunities for such studies in school. Probably nothing has so handicapped teachers of Nature Study as want of a definite plan. In a subject presenting so many phases, and a field so extensive, it follows that the absence of definiteness in the work, even among well prepared teachers, will result in a more or less chaotic state of affairs. An outline may, therefore, serve a good purpose, but only in so far as it does not interfere with the individuality of the teacher. It should be remembered that plans are merely suggestive. It should be remembered, furthermore, that Nature Study teachers are themselves not agreed as to just what should be attempted, and when and how it should be done. For an elaboration of the suggested topics in this course, teachers are referred to the extensive literature on the subject. Having in mind the difficulty of securing books in many schools, and the large amount of worthless so-called Nature Study literature, an effort has been made to include in the bibliography only such books as will be of direct value to teachers, and only such books as are unquestionably suitable for children. At the risk of incurring the disfavor of a large number of devotees of Nature Study, two classes of books have been omitted from the bibliography —those whose scientific accuracy is open to question, and those in which mythology is injudiciously mixed with elemen-

tary science. Unfortunately these classes include the most popular of Nature books. In defense of this discrimination it should be said that the field of good literature, whose scientific accuracy is beyond question and whose pedagogy is sound, is so large; and that the facts of nature when properly presented to the child, appeal to him so irresistably as to need no embellishing, that they render both classes, aside from their pernicious influences, of no value. In view of this statement an explanation should probably be made regarding the appearance of the *Wood Folk Series* in the bibliography. While freely admitting the probable inaccuracy of some of Mr. Long's conclusions, it does not follow that his observations have necessarily been inaccurate. There are two reasons why his books should have a wide circle of readers among teachers and pupils of mature years. It is certain, however, that the series is not adapted for use in the grades, except, possibly, the highest. These reasons referred to are, first, the author has experienced a wide range of accurate observations, and not being concerned in a matter of comparative psychology, we may well disregard some of his conclusions in view of the facts observed. The second reason is, the author has presented so skillfully and so beautifully the side of the Wood Folk, that the reading of his books arouses a love, and respect, and a wholesome regard for living things which alone would make them well worth the while. For, whatever else Nature Study may accomplish, if it does not do this—if it does not teach the child to love and respect all living things, to see that everything has its proper sphere and place, and to so regard life that neither animal nor plant will be sacrificed, except its death serve some useful purpose, it has no excuse for its existence.

One book on Nature Study, Hodge's *Nature Study and Life*, deserves special mention, and should find a place on the table of every teacher. Written by the head of a university department, himself a thoroughly good naturalist and a lover of children, it constitutes, by far, the most valuable contribution of its kind to Nature Study literature.

H. L. A.

Outline of Nature Study Course

FIRST GRADE

I. Animals.

CAT AND DOG. CHICKEN AND DUCK.*

Cat—

1. Habits and food.
2. Structural adaptations.
   - *a.* Feet, claws, paws.
   - *b.* Eyes, ears.
   - *c.* Fur and hair.
   - *d.* Mouth and teeth.
3. Value to man in the home; in connection with grain raising in certain localities; destruction of birds by the cat.
4. Relations of the cat.
   Wild cat, tiger, etc.

Dog—

1. Uses to man.
   - *a.* Care of sheep and cattle. Shepherd and collie.
   - *b.* Beast of burden. Newfoundland and Eskimo,
   - *c.* Messengers. St. Bernards.
   - *d.* Hunters. Pointers and Setters.
   - *e.* Companions. Love and Fidelity.
2. How adapted to be of use to man.
   - *a.* In connections with flocks.
   - *b.* As beasts of burden.
   - *c.* As messengers.
   - *d.* As hunters.
   - *e.* As pets and companions.

Chicken and Duck—

1. What kind of food does each use?
2. Compare their mouths and bills.
3. Compare their feet. For what, particularly, is each adapted?
4. What relation between the character of their food, and their bills and feet?

*Pet cats and dogs may be brought to school.
Excursion should be made to some nearby pond or barnyard to study fowls.

5. How is their body covering adapted to their environment?
6. Uses to man.

II. **Plant Life.** (Autumn)

Garden Work—Study of vegetables planted previous spring—tomatoes, beets, turnips, potatoes, squashes, pumpkins, peas, beans, lettuce, radishes.

a. Which grow in the ground? Which above the ground?

b. What makes them valuable to man? Does this same reason result in any benefit to the plant? How?

c. Describe their flowers. What becomes of the flower when it fades?

d. Collect seeds of each kind. Where are the seeds? Are there many? Will we plant the seeds in the spring to raise new plants? If not, what?

e. Are the plants herbs, vines, or shrubs? Which will resist the cold longest, and why?

Trees—Study the preparation of the trees for winter.

a. Collect leaves of the oak, maple, and elm in the early fall, then again about Nov. 1. Observe characteristic colors of each.

b. Note the falling of the leaves. Where do they become detached? Why do most trees drop their leaves?

c. Examine buds, preferably of the horse chestnut. Tear one to pieces and note the sticky coating on the outside, and the woolly covering of the little leaves.

d. How is the tree prepared to withstand the wind, snow, and ice of winter?

Spring—Examine buds of the hickory and horse-chestnut. Watch the parting of the scales and the development of leaves and flowers from their buds. (Branches bearing buds may be brougnt into the schoolroom late in the winter, the ends of the stems kept in a jar of water, and the development of the buds watched.)

SECOND GRADE

I. Animals.

HORSE AND COW.

Horse—

1. Care and food.
2. Uses to man.
3. Abuses—overdriving and overworking.
4. How a horse should be treated.
5. Laws regarding cruelty to animals.

Cow—

1. How and what she eats.
2. What man receives from the cow.
   a. Milk: value as food.
   b. Butter and cheese.
3. How a milch cow should be cared for.
4. The care of milk.
5. Butter and cheese making.

Birds—Robin, English Sparrow, Bluebird, Woodpecker.

1. Colors, size, and general appearance.
2. Why we should try to preserve beautiful and beneficial birds.

Frogs and Toads—

1. Differences in habits, habitat, and food.
2. Value of the toad to man.

Insects—Grasshoppers, Crickets, Katydids, Mantids, Walking-sticks, and Cockroaches.

1. General appearance of each.
2. Where they live and what they eat.
3. Insect calendar.*

*Keep a record on the blackboard of the date when the insect is first discovered in the spring:

Date	*Name of Insect*	*Pupil who first sees one*
April 10	Grasshopper	William Smith

II. **Plant Life.** (Spring)

Competitive Flower Rearing—Distribute seeds of the dwarf nasturtium to each child, and let him find out for himself, by reading or by inquiring the best way to prepare the soil, rear the plant, etc. After a sufficient time have the results brought to school to see who has succeeded in rearing the best plants.

Garden Work—Study of vegetables. Plant and tend seeds of the pea, bean, corn, tomato, lettuce and radish. Study as in Grade I, adding questions of soil preparation, manner of planting, care, and value.

Study of Wild Flowers—Buttercup, Spring Beauty, Bluet, Dandelion, Trillium, Violet, Sweet William, and Bloodroot. How to know these, when they bloom, and where they grow.

Flower Calendar—Prepare a record, as with insects, with date, name of flower, and name of pupil who first finds the flower in the spring.

Trees—Soft maple, elm, and cottonwood. Learn to identify the flowers, and observe the development of the fruit therefrom. Collect seeds, (all three form their seeds in the spring), and save to propagate.

Flowerless Plants—Learn to identify two or three common ferns. How do they reproduce? Where do they grow, and under what conditions?

III. **Earth, Sky, and Weather.**

Formation of Soil.

1. How the rocks decay and are worn away to form soil.
2. What else is in soil besides decayed rock?

Sky Observations.

1. Position of the sun; color, size, and general appearance at sunrise, sunset, and in the middle of the day.
2. Rising of the moon, and different phases of the moon.

*Weather Record.**

Beginning in the spring keep a record for several weeks something like the following:

Date	Bar.	Max. Temp.	Min. Temp.	Condition of Sky.	Direction of Wind
Apr 2	30.75	72	59	Clear	S W.
3	30.05	76	65	Partly Cloudy	E.

Garden Work.

(Autumn) Study of vegetables planted preceding spring.

IV. Hygiene.†

Simple Lessons in Cleanliness.

The following are suggested for this grade:

1. The importance of clean faces and hands.
2. Not to put the fingers in the mouth.
3. Not to eat anything someone else has been eating of, such as apples, cakes, etc.
4. Not to rub the eyes with the hands.
5. Not to spit on the slate, floor or sidewalk, or at all unless absolutely necessary.
6. To turn the head aside when coughing or sneezing.
7. Not to put the fingers in the nose, or to wet them with saliva when turning the pages of a book.
8. Not to put pencils in the mouth.

THIRD GRADE.

I. Animals.

SHEEP AND RABBIT.

Sheep—

1. General characteristics.
2. Food. Adaptations of teeth to kind of food.

*Any record kept continuously becomes monotonous and interest therein fails. It is better to continue weather records for rather brief periods, covering different seasons in different grades.

†Every room in every school should have a health brigade such as the one described in *Nature Study and Life*. The importance of abandoning dusters and dry cloths, and the substitution therefor of the wet cloth cannot be overestimated. The enforcement of laws of hygiene and sanitation is best accomplished by enlisting the interest and the assistance therein of the children.

3. Uses to man. Preparation of wool for the market and its conversion into clothing.
4. Comparison with the cat, dog, horse, cow.

Rabbit—A pet rabbit should be kept and carefully tended in the schoolroom.

1. General characteristics.
2. Its enemies and how it escapes them.
3. Food. Structural adaptations of teeth.
4. The rabbit's nest, the young rabbits, and how the mother cares for them.
5. Compare the mouths and teeth of cat, dog, horse, cow, sheep, and rabbit.

Birds—Blue-jay, crow, oriole, humming bird, red bird, swift.

1. General characteristics, color, size, form, plumage, etc.
2. Habits. Solitary or social.
3. Mating and nesting.
   a. Site and material for nest.
   b. How the nest is built.
   c. The eggs: how watched and cared for.
   d. The young birds: appearance, food, and how fed.
   e. The development of the young bird: his early lessons, and the difficulties and dangers he encounters.
4. Value to man.
   a. As destroyer of insects.
   b. Aesthetic value.

Bull frog and tree frog—

1. General appearance, size, color, sounds made, etc.
2. Habitat, habits, and food.
3. Uses to man.

Insects—Locust, (short-horned grasshopper), stag beetle, giant water-bug, butterfly, house-fly, cockroach, carpet beetle.

By far the most important thing in connection with insect

study is the working out of life-histories by the children. Larvæ of all kinds should be brought into the school-room and carefully tended and watched. For directions for keeping and feeding larvæ see *Methods and Materials.*

1. A few prominent external characteristics.
   a. Body divisions, and segmentation.
   b. Number and character of legs.
   c. Number and character of wings.
   d. Eyes, compound. Simple, if any.
   e. Method of breathing.
2. Food of the larvæ; of the adult.
3. Habitat and habits.
4. Means of protection and defense; protective resemblance.
5. Relations to man; useful or harmful?

II. **Plant Life.** (Spring)

Competitive Flower Rearing.—Bachelor's Button.

Garden Work—Plant and tend parsnips, beets, lima beans, sweet potatoes, onions.

Trees—The willows. The different kinds, their flowers, leaves, and general habits. Grow some yellow willows from cuttings.

(*Autumn*) *Wild Flowers*—Golden rod, oxeye daisy, dog fennel, blue vervain, boneset. Study as in grade II.

Flower Calendar—

Trees—The oaks. Learn to identify the different kinds by their leaves and bark. Collect fruits of the different oaks.

Flowerless Plants—Ferns, horse-tails, and club-mosses.

1. Learn the names of as many kinds as it is possible to find.
2. Note the conditions of light, soil, and moisture in which each grows.

III. **Earth, Sky, and Weather.**

Soils.

1. Kinds. Classify as to relative amounts of sand and clay.
2. Humus. Nature of, how formed, value of, etc.
3. Water in soils. What soils take up water most readily? What soils retain water best? What is the ideal soil relative to the absorption and retention of water?

Sky.

1. The phenomena of day and night.

Weather.

1. The phenomena of rain and hail.

IV. **Hygiene.**

The Skin.

1. How it protects the body.
2. How it helps to eliminate waste products.
3. The relation of exercise to the skin.
4. The relation of clothing to the skin.
5. The importance of frequent bathing in keeping the skin healthy.

FOURTH GRADE.

I. **Animals.**

Birds—Night-hawk, whippoorwill, phœbe, chickadee, downy-woodpecker, catbird. Study as in grade III, noting, in addition, more about the habits, food, season of the year, and time of day when seen, and their relations to man.

Fishes—Goldfish. Keep some goldfish in an aquarium jar in the room. Feed from time to time with prepared food. Observe the manner of taking food, general position in the water, locomotion, uses of different fins, and breathing. Explain in a simple manner the difference between breathing in air and breathing in water.

Frogs and Reptiles—Green frog and wood lizard.

1. Habits and habitat.
2. External structural characters.
3. Compare the two structurally.
4. Their value as destroyers of insects.
5. Compare the wood lizard with other lizards. Impress the children with their harmlessness, and explain that lizards are not scorpions.

Insects—May beetle, squash bug, butterfly, and housefly.

1. Study as in the preceding grades, noting a few additional structural characters. (See outline for field study of insects under *Methods and Materials*.
2. Insect calendar.

Other Arthropods—The Crayfish. Have several crayfish brought into the school room and kept for two or three days. Feed them and observe their habits.

1. How are they adapted to the places where they live?
2. Means of locomotion. Compare locomotion in water and on solids.
3. Means of protection and defense.
4. The sense organs.
5. Principal structural characters.
   a. Body divisions.
   b. Appendages of the cephalothorax: antennæ, antenules, mandibiles, maxillæ, maxillipeds, and chelapeds. Uses of each.
   c. Appendages of the abdomen: the swimmerets, and caudal fin. Uses of each.
6. Molting. Observe the process, if possible, and compare with metamorphosis in insects.
7. The life of the crayfish out of doors.
8. Relatives of the crayfish; the lobster, crab, and sow-bug.

II. **Plant Life.** (Autumn)

Garden Work—Study of vegetables planted preceding spring—parsnips, beets, lima beans, sweet potatoes, onions.

Trees—The walnut and hickory.

1. General forms, characters of the leaves, wood, and bark.
2. The fruits.

(Excursions to the woods to gather nuts may be made both pleasant and profitable.)

Competitive Flower Rearing (Spring)—The Calliopsis.

Wild Flowers. Small-flowered buttercup, Solomon's seal, hepatica, jack-in-the-pulpit, columbine, star-grass. (Discourage the children from plucking the flowers extensively or indiscriminately. Teach them to admire them as nature intended they should grow. Frequently caution against the ruthless destruction of life.)

Flower Calendar.

Trees—The Dogwood and Service-berry. In addition to the study of these as with trees previously studied, observe, especially, the flowers, and later the fruit.

Flowerless Plants—Liverworts and mosses.

1. Identify a few common mosses and liverworts.
2. Collect moss when both generations are present, and explain, in a simple manner, alternation of generations in this group.

III. **Earth, Sky, and Weather.**

Soil.

1. Preparation for use. Plowing, harrowing, and rolling.
2. Objects in cultivating the soil.
3. Effects of cultivation upon the growth of plants.
4. Effects of cultivation upon the absorbing and retaining of water by the soil.

Sky—The Solar System.

1. Explain the general relations of the sun and the planets.
2. Explain the revolution of the earth in its orbit.

3. Identify the planets, and compare as to size, and distance from the sun.
4. Study the moon and its relation to the earth.

Weather.

The phenomena of sleet and snow.

IV. **Physiology and Hygiene.**

Respiration.

1. A brief description of the respiratory organs.
2. Air. Its composition. How used in respiration.
3. Proper and improper manners of breathing. Deep and superficial breathing.
4. Care of the respiratory organs.
   a. By deep breathing.
   b. By breathing through the nose.
   c. By avoiding impure air in poorly ventilated rooms.
   d. By protecting them against exposure to cold.
   e. By exercise in the sunlight and pure air.
5. Some diseases of the respiratory organs. Their causes, nature, and how avoided.
   a. Tuberculosis.
   b. Diphtheria.
   c. Pneumonia.
   d. Croup.

FIFTH GRADE.

I. **Animals.**

Birds—Crackle, martin, sparrow-hawk, chicken-hawk, rice-bird.

1. Study as in preceding grades.
2. Compare grain feeding birds with birds of prey.
3. How do birds not positively harmful make us better and happier?

Fishes—Perch and catfish.

1. How and where they live and what they eat.
2. How they differ from the gold fish and from each other.

Frogs and Reptiles—Leopard frog. Green snake.

1. Compare the leopard frog with others studied.
2. Habitat of the green snake.
3. How adapted to its surroundings.
   a. By color.
   b. By its slender body.
4. Its food and how he secures it.
5. Its harmlessness.

Insects—Searcher beetle, chinch bug, moth, horse-fly, dragon-fly, and bumblebee. Study as in preceding grades and according to the outline for field study. Compare with those previously studied.

Other Arthropods—Spider, daddy-longlegs, wood-tick, and scorpion.

1. Study the spider structurally as to body divisions, eyes, legs, mouth-parts, and manner of breathing.
2. The spider's web. How made and for what use.
3. The food and habits of the spider.
4. Compare with these other arachnids.

II. **Plant Life.** (Spring.)

Competitive Flower Rearing—Mimosa (Sensitive Plant.)

Garden Work—Plant and tend carrots, rhubarb, asparagus, horse-radish, spinach, cabbage, and cucumbers.

(*Autumn*) *Study of Wild Flowers and Weeds*—Iron-weed, Jamestown weed, dog-fennel, golden-rod, boneset, blue vervain, pig-weed, and thistle.

1. Their general nature, identification, etc.
2. Their special adaptations.
3. How they reproduce.
   a. By underground stems.
   b, By seeds.
4. Are they annuals or biennials or perennials?
5. Why do weeds thrive where other plants will not grow?

Flower Calendar—

Trees—Beeches and birches. Study as in preceding grades.

Flowerless Plants.—The Algæ.

1. Collect pondscum (spirogyra) from some stagnant pool, and examine in a white dish or on white paper.
2. Note the presence of algæ aaound cisterns and wells, sidewalks, the north sides of houses, fences, and stone walls, on wet mud, and in stagnant and fresh water.
3. Explain that sea-weeds are algæ.

III. Earth, Sky, and Weather.

Soil—How to enrich and make fertile.

1. By proper rotation of crops.
2. By green manuring.
3. By fertilizers.

(Introduce here the subject of nitrogen-fixing bacteria and the plants whose roots they inhabit, manures, and chemical fertilizers.)

Sky—The Stellar System.

1. The relation of the stars to the bodies of our solar system.
2. The identification of several important constellations.

IV. Physiology and Hygiene.

Digestion, Nutrition and Secretion.

1. The general nature of and organs concerned in these processes.
2. The necessity for food. Various classes of foods—proteids, carbohydrates, fats and oils, and minerals. Value of common food stuffs.
3. The Digestive process.
   a. Prehension.
   b. Mastication and insalivation.
   c. Deglutition.

d. Chymification (stomach digestion).
e. Chylification (intestinal digestion).
f. Absorption.

5. Secretion as related to digestion.
   a. Saliva.
   b. Hydrochloric acid and pepsin.
   c. Pancreatic fluid.
6. Secretion in general.
   a. General nature of the process.
   b. Illustrations.
7. Care of the digestive organs.
   a. The teeth.
   b. The stomach.

In this connection a number of hygienic principles should be taught, as brushing the teeth, visiting the dentist to detect decay, the avoidance of extremes of heat and cold in food and drink, the avoidance of indigestible foods, and probably most important of all the necessity of habits of regularity in emptying the bowels. Undoubtedly the foundation of most of the constipation and its multitude of resultant diseases is laid in childhood, and the teacher can confer upon the individual and upon the race no greater benefit than to develope, as much as possible, in childhood those habits of regularity which if not learned then, are learned too late. This subject should be handled without reserve, and in place of the existing false modesty, a healthy sentiment about this and similar questions should be created.

GRADE SIX.

I. **Animals.**

Birds—Meadow-lark, quail, red-winged blackbird, kingbird, bobolink, indigo-bunting.

1. Study as in preceding grades.
2. Make a study of those parts of the game laws affecting birds, of this state, and so far as is available, of other states.

Fishes—Minnow and bass.

1. Study as ih preceding grades, comparing as to size, development, etc.
2. Why are some fish classed as *game fish?*

Frogs and Reptiles—Toad and bullfrog. Black-snake.

1. Collect eggs of the toad and frog and study their development.
2. Observe the "tadpoles" in the aquarium and in nearby streams from time to time, and note the changes that take place, especially,
   a. in the development of the legs.
   b. In the absorption of the tail.
   c. In the appearance of lungs instead of gills.
   d. In the abandonment of the aquatic habit for the terrestial.

Insects—Lady beetle, aphid, cecropia moth, braconid fly, honey bee, damsel fly, corydalis.

1. Study as preceding insects were studied.
2. Discuss the economic importance of the lady-beetle (in connection with scale insects); the honey bee (with relation to pollination); and the braconids (as parasitic on the tomato-worm).
3. Discuss the destructiveness of aphids and their peculiar life habits.
4. The aphid, cecropia moth, and braconid can easily be propagated in the school room and many valuable lessons learned therefrom.

Other Arthropods—The centiped and thousand-legs.

1. Examine as to segments, eyes, legs, etc.
2. Compare with other arthropods studied, and make a table like the following:

TABLE OF COMPARISONS OF ARTHROPODS

NAME	BODY DIVISIONS	LEGS	EYES	ANTENNAE	BREATHING	HABITAT
Grasshopper (Insect)	Head, Thorax, Abdomen	six	two compound	two	Tracheae	Fields and Woods
Crayfish (Crustacean)	Cephalothorax Abdomen	ten thoracic	two compound	four	Gills	Ponds and Streams
Spider (Arachnid)	Cephalothorax Abdomen	eight	two, six, or eight, simple	none (?)	Tracheae	Houses, Fields, and Woods
Centipede or Thousand-legs (Myriapod)	Head, Thorax, Abdomen	one or two pairs to each segment except first and last	two compound (if any)	two	Tracheae	Under Stones and Logs

3. From this table construct logical definitions of the animals studied, something like this: *An insect is an Arthropod, (i. e., an animal having a segmented body and segmented appendages), with a separate head, thorax, and abdomen, six legs, two compound eyes, two antennae, and which breathes by tracheæ.*

II. **Plant Life.** (Spring).

Competitive Flower Rearing—Pansy.

Garden Work—Melons and strawberries.

1. Plant seeds of several kinds of melons, noting which kinds are best, and which thrive best in a particular soil.
2. Set out strawberry plants. Tend carefully and note their general requirements as to soil, light, moisture, etc., and their means of propagation by "runners."
3. Have the children sell the products of their gardens, compute the cost of production, subtract from their gross receipts, and estimate their net profits. In connection with garden work, much of this may be done, and valuable lessons of thrift and industry impressed upon the child.

Wild Flowers—May-apple, clematis, lady's slipper, poison-ivy, woodbine, trumpet creeper.

Flower Calendar.

Trees—Catalpa, horse-chestnut, tulip tree, poplar, mulberry, sycamore, beech.
Study these as preceding trees were studied.

Flowerless Plants—Fungi.

1. Examine a common mushroom, its habitat, peculiar habits, structure, etc.
2. Search the woods for different kinds of mushrooms, toad-stools, puff-balls, and other fungi.

3. Examine moulds on fruit, jellies or preserves, bread, living plants. Distinguish between the parasites and the saprophytes.
4. Study especially disease producing fungi on cultivated plants—rust and smut of grains, downy mildew of the grape, and mildews on orchard trees.
5. Summarize the general character of the fungi.

III. **Earth, Sky and Weather.**

Soil.

1. How we should treat the soil so as not to exhaust its resources.
2. The virgin fertility of our soil.
3. Our duty to posterity in caring for the soil.

Sky—Clouds and fogs.

1. Causes, and different kinds. Their significance.

Weather—The Weather Bureau.

1. Forecasting, how done, instruments and apparatus used, and general conduct of the department.
2. Relations of the Weather Bureau to our industries, especially agriculture.

IV. **Physiology and Hygiene.**

Blood and Lymph. The Circulation. Food.

1. The nature of blood and lymph. What the blood does, and how. How and why the blood becomes impoverished.
2. The organs of circulation. What circulation does.
3. How food repairs the waste in the body through the blood. Review digestion and assimilation. What is a food? The necessity for a mixed diet. Discuss the values of the commoner foods.
4. The relation of clothing and exercise to the blood and circulation.

GRADE SEVEN.

I. **Animals.**

Birds — Wood-thrush, mocking-bird, bank-swallow, snipe, and dove.

1. Study as in other grades and compare with other birds.
2. Compare the songs of the thrush and mocking-bird with the songs of other birds.
3. Discuss the captivity of birds. Protest against the captivity of any birds on moral, ethical, and æsthetic grounds.

Fishes—Croppie, trout and salmon.

1. Study as to habitat, habits, size and color.
2. Note the commercial importance of these and other fishes.

Reptiles—Venomous snakes. Rattlesnake, copperhead, moccasin.*

1. Study their habitat, habits, food, and general characteristics.
2. Compare with non-venomous kinds and note the distinctions between them in
   a. Shape of the head and neck.
   b. Character of plates and scales.
   c. Presence of fangs in venomous snakes.
3. Explain the poison apparatus. Discuss the effects of the poison. Correct exaggerated ideas about venomous snakes.
4. Distinguish, carefully, between the venomous and non-venomous snakes, and point out, especially, the many harmless varieties.

*These three snakes all belong to the rattlesnake family, and are all venomous. It should be noted that both the copperhead and moccasin are in certain localities called "cotton-mouths." It should also be noted that the natrix, a harmless aquatic species which mimics the moccasin is constantly confused with the latter. The so-called spreading-adder, in reality the hognose, to which venomous qualities are usually ascribed, is entirely harmless. It would hardly seem necessary to add that the black-snake, milk snake, garter snake, green snake and many other common kinds are harmless.

Insects—Walking-stick, rhinocerous beetle, bed-bug, luna moth, ichneumon fly, ant lion.

II. **Plant Life.** (Autumn).

Garden Work. Garden and Orchard Fruits.

In this grade the study of garden fruits—raspberries, blackberries, gooseberries, currants, grapes—and the study of horticulture may be taken up. The time and opportunities must dictate the nature and extent of this work.

Competitive Flower Rearing. (Spring) Carnation.

Wild Flowers—Oxalis, false-dandelion, dog-tooth violet, and various grasses.

Flower Calendar.

Trees—Comprehensive study of trees of the vicinity. (See Methods and Materials.)

Flowerless Plants—The Bacteria.

1. Explain the nature of the bacteria, their habits, place in life, size, morphology, and kinds.
2. Illustrate the action of bacteria in putrefaction, suppuration, souring of milk, formation of vinegar. Describe the action of the yeast-fungous in bread making. (The yeast is introduced here, while not one of the Schizomycetes, for the reason that it furnishes a good illustration of reproduction in a micro-organism.)
3. Discuss the pathogenic bacteria, and diseases caused by specific organisms.
4. Discuss the questions of infection, immunity, (including vaccination), antitoxin, antiseptics, disinfection, and sterilization. Many valuable lessons may be learned from each of these subjects.

III. **Earth, Sky and Weather.**

Soil—Drainage.

1. Its application to small tracts by individuals.
2. The draining of our swamp lands.

Weather—Cyclones, cloud-bursts, electrical storms.

IV. **Physiology and Hygiene.**

Muscles, Nerves, and Bones.

1. The structure of each.
2. Their functions.
3. The principle of the lever. Find illustrations of the three kinds in various parts of the body.
4. The relation of the nerves to muscles and bones.
5. How to care for these parts of the body. In this connection review and unify the idea of the health of the body being dependent upon four things: proper food, proper clothing, proper rest and proper exercise. Make each of these the subject for daily lessons.

GRADE EIGHT.

I. **Animals.**

Birds—Wild duck, wild goose, woodcock, eagle, heron, owl.

1. Study each as to habits, haunts, characteristics, and food.
2. Review the game laws of your state.
3. Construct food charts and life charts of the principal birds in the locality (*Nature Study and Life*, p. 323 and pp. 342, 343).

Reptiles—Terrapins and Turtles. Study their habits, food, life histories, and principal structural characters.

Insects—Make a comprehensive study of the insects of the vicinity, examining several specimens of each of the seven or eight principal orders. With the knowledge of habits, life histories, and structure gained throughout the grades construct a table of resemblances and differences like the following:

TABLE OF COMPARISONS. INSECTS

NAME	BODY DIVISIONS	ANTENNAE	EYES	MOUTH-PARTS	WINGS	LEGS	LOCOMOTION	BREATHING	Metamorphosis	LARVA
Grasshopper	Head Thorax Abdomen	2 short	2 compound	Biting	4 Hind pair folding longi-tudinally	6	Walking Jumping Flying	Tracheae	Incomplete	Nymph
Cricket	Head Thorax Abdomen	2 long	2 compound	Biting	4. Hind pair folding longi-tudinally	6	Walking Jumping	Tracheae	Incomplete	Nymph
Butterfly	Head Thorax Abdomen	2 knobbed	2 compound	Sucking	4 Scaly	6	Walking Flying	Tracheae	Complete	Caterpillar
Moth	Head Thorax Abdomen	2 feathery	2 compound	Sucking	4 Scaly	6	Walking Flying	Tracheae	Complete	So-called Worm
Beetle	Head Thorax Abdomen	2	2 compound	Biting	4 Hind pair sheath wings	6	Walking Flying	Tracheae	Complete	Grub
Giant Water-bug	Head Thorax Abdomen	2 concealed	2 compound	Sucking	4	6	Walking Flying	Tracheae	Incomplete	Nymph
Cicada	Head Thorax Abdomen	2	2 compound	Sucking	4	6	Walking Flying	Tracheae	Incomplete	Nymph
House-fly	Head Thorax Abdomen	2	2 compound	Sucking	2 second pair rudimentary	6	Walking Flying	Tracheae	Complete	Maggot
Dragon-fly	Head Thorax Abdomen	2	2 compound	Biting	4	6	Walking Flying	Tracheae	Complete	Nymph
Corydalis	Head Thorax Abdomen	2	2 compound	Biting	4	6	Walking Flying	Tracheae	Complete	Nymph
Bumblebee	Head Thorax Abdomen	2	2 compound	Biting and Sucking	4 membrane-like	6	Walking Flying	Tracheae	Complete	Nymph

II. **Plant Life.**

Competitive Flower Rearing. Chrysanthemum.

These may be made valuable lessons in floriculture. Have the children "slip" the chrysanthemums in early spring and cultivate some in pots and some out of doors. About December 1 have a chrysanthemum show in the school room.

Extensive Farming.

1. Wheat, corn, oats, peas, timothy, clover, and alfalfa as crops adapted to our soils.
2. The management of a one hundred acre farm.
   a. The division of the ground for the various crops.
   b. The preparation of the soil, and sowing the seeds.
   c. Harvesting, gathering, and storing.
   d. Marketing.
   e. Cattle about the farm. Number and care.
   f. The care of farm machinery.
   g. How rainy days may be spent to advantage.

Select a piece of land of about an hundred acres and have the children study and plat it, showing where they would locate the house, the barn, the outhouses, the orchard, and where they would plant the several crops for each of three successive years.

3. Farming as a business. Discuss the qualities necessary to success, why so many fail, and compare the conduct of a farm with that of any other business or industry.

Forestry.

1. The principal forest trees of our State.
2. The care and protection of forests.
   a. Against injury by animals.
   b. Against injury by fire and wind.
   c. Against injurious plants.
   d. Against man.
   e. Laws protecting forests.
3. Raising or keeping up the forest.

4. The value and uses of our forests.
   a. Lumbering.
   b. Resin and turpentine.
   c. Mast and seeds.
   d. Pasturage.
   e. Game and fish.

Wild Flowers.—Make a study of representatives of the principal families of flowering plants from those of simple structure to the complex compositae.

III. **Physiology, Hygiene and Sanitation.**

1. The Special Senses.
   a. Study the special senses, voice, and speech.
   b. The care of the sense organs, especially the eyes.
2. Study the problems of municipal sanitation—water supply, sewers and sewage, cesspools, street-cleaning, infectious diseases, and the work of the Board of Health.
3. Review the entire subject of Hygiene.

Nature Study is learning those things in nature that are best worth knowing, to the end of doing those things that make life most worth the living.—HODGE, *Nature Study and Life.*

The great benefit which a scientific education bestows, whether as training or as knowledge, is dependent upon the extent to which the mind of the student is brought into immediate contact with facts—upon the degree to which he learns the habit of appealing directly to Nature.—*Huxley.*

SUGGESTIONS REGARDING METHODS AND MATERIALS.

Field Studies

It seems hardly necessary to point out that the study of many of the most important phases in the life history of both animals and plants can be be carried on only out-of-doors. A failure to take advantage of the opportunities afforded by field studies is a failure to fully comprehend and utilize the chief opportunity in nature study work, and defeats the purpose of such work. Yet no phase of the subject calls for so much tact and skill on the part of the teacher, and demands so much of ability and energy. The time for work out-of-doors must be determined by local conditions. It may be an hour during the school period may be utilized, or after school or on the regular school holidays children and teacher may spend such time as may be profitably and conveniently used in this way. It is advisable to limit the number on such occasions. There is the danger of a diversion of interests which may make the lesson degenerate into mere play. Both the danger and the secret of avoiding this danger are admirably set forth in the following extract:

> It is difficult, unnecessary and unwise to attempt to maintain out of doors the order which is required in the school. Such order will defeat the purpose of the field lesson. On the other hand a lesson in which no order is maintained, which degenerates into a frolic or picnic, is not merely of little value, but may bring discredit upon all the work in nature study, and tend to postpone the time when this natural method of studying the children's natural environment shall be followed in other subjects, such as local geography and history. The secret of a successful field lesson is this: a definite aim or object understood by each pupil as well as by the teacher, definite work for each pupil, followed by a definite report on and review of what is observed. In a field lesson, with the freedom and lack of restraint, and with distracting surroundings, from which the schoolroom is largely free, definiteness in aim and plan is more important than it is in any other work. SCOTT'S *Nature Study and the Child.*

This suggestion of definiteness does not mean that field lessons should ever degenerate into a study of mere detail. Every fact observed should possess some interest for the child,

and should bear some relation to other facts observed. Agassiz's remark that "Facts are stupid things until brought into connection with some general law" is nowhere as true as here. In field studies, as everywhere else in nature study we should remember always our object, as Dr. McMurrey says, in substance, to familiarize a child with his surroundings, to bring him in harmony with environment, and as Mr. Burroughs has so admirably stated it:

> The main thing is to feel an interest in Nature—an interest that leads to a loving unconscious study of her. Not entirely a scientific interest, but a human interest as well. * * * If one could number all the trees of the forest, and all the leaves upon the trees, what would it profit him? To know the different kinds of trees when you see them, and the functions of the leaves upon them—that were more worth while. I have read studies of leaves that were just as profitless as to know their number. * * * I hardly know why I am impatient when people come to me with their hands full of different leaves, and ask me what tree this is from, and this, and this? If your business is not with trees, if you live in the city and care mainly for city things, why bother about the trees, unless for the pleasure of it during your summer excursions into the country; and if it affords you pleasure, you will not want anyone to tell you: you will want to identify the trees themselves. JOHN BURROUGHS, *Introduction to The Nature Library.*

Morphology and Structure

While fully according to ecology and physiology the most important place in the study of living beings, it is important that those morphological characters should be studied which are necessary to our understanding of the former. Again quoting from Mr. Scott, "In general, in the work with children of any grade, only those features of structure, or those properties should be studied or emphasized which either throw light on function (including use to man) or aid in comparison and classification, so far as the children of that grade study or can understand these."*

So much of structure, then, is to be studied as will throw light upon function, and, it should be added, upon *life-relation*, because ecology and morphology are as closely related as physiology and morphology. The structural characteristics

*Scott's Nature Study and the Child, p. 210.

may be studied out-of-doors, but can probably best be studied in the schoolroom. This does not mean that the room must be converted into a laboratory with dissecting instruments and microscopes. True it does serve the purpose of a laboratory; and in defense of the laboratory, in view of Mr. Burroughs' hostility to laboratory work, it should be said that a laboratory is not necessarily a place for dissection and microscopic work, but is, after all, *simply the most convenient place to carry on a certain line of observations.* For ecology, the whole of out-of-doors is the laboratory. But if in the pursuit of a certain thing a shed, a stable, an attic, or a well lighted, conveniently furnished room offers the best opportunities, why should it not be used? Morphology offers opportunity for comparison which no other phase of the subject possesses, and comparison is important in developing the powers of generalization and logical thinking in the child. In general, then, it may be said that so much of morphology may be studied as bears a direct and important relation to physiology or ecology, and it may be done under those conditions which are found to be most convenient and most conducive to satisfactory work. There can be no possible objection to the teacher owning dissecting lenses, and a compound microscope, and putting the former in the hands of the children, and occasionally showing them structures under the latter. Here, again, the object should be to make clear some point bearing a relation to what they have previously observed, rather than simply arousing their curiosity at the wonderful.

Illustrative Collections

Just when and to what extent children should be encouraged to collect plants and animals is a serious question. Two general principles may be laid down: the child should never be permitted to collect specimens which cost the life of the animal or plant in the early grades, and when permitted in the higher grades the collecting should be restricted to plants and insects. Under these conditions the value of collections can hardly be over-estimated. But it should be clearly understood by the

child that his collecting is not to be indiscriminate or haphazard, but he is to have a definite object in view, and his collection is to illustrate something definite.

Insects. An excellent method of mounting insects is described by Dr. Hodge.* Two rectangular pieces of glass of the same size are used. (Discarded photographic negatives of the 5x7, 6 1-2x8 1-2, or 8x10 size are excellent for this purpose). Strips of wood are glued to the edges of one piece of glass, making a box with a glass bottom the depth of the strip.† The insects, having been previously killed and pinned out, are fastened to the lower glass by a drop of glue on the thorax, the second glass laid over them and the whole sealed by a piece of passe-partout. This way of mounting has the advantage of showing both surfaces of the insects. Another method is the one suggested for plants, in which a wooden back is substituted for the second glass and the whole filled in with absorbent cotton. For directions for collecting, killing, net-making,‡ pinning, etc., reference may be made to the numerous text books on the subject.

Spring Flowers. These offer the best opportunities for herbarium collections because of their size, number, and the season at which they bloom. Herbariums should consist simply of a double sheet of paper for each specimen and substantial covers. All printed outline for description should be omitted. No description should accompany specimens except the name, habitat and a brief reference to habits. Caution the children against gathering any more than enough for their immediate use.

Weeds. The fruits and seeds of weeds make both interesting and instructive collections. They may be collected, studied, the power of propagation estimated therefrom, and preserved either by placing each kind in a vial or bottle and

*Hodge's Nature Study and Life, p. 53.

†In the Cape Girardeau State Normal School poplar strips 1-4 inch thick and 1-4, 1-2, and 3-4 inches deep are used. It has been found these sizes will accommodate all insects.

‡The Simplex Net Co., of Lake Forest, Illinois, manufacture excellent insect nets The prices for the air nets are 75 cts. each; for water nets, 60 cts; for the two combined, $1.10.

labeling carefully, or, by mounting in the following manner: A piece of soft pine 12x18 inches, (or smaller), is selected and dressed. With a 3-4 or 1 inch bit holes are bored to a depth of about half an inch. A piece of paper or cardboard is cut the size of the board with openings corresponding to the holes. The compartments are now filled with seeds, each carefully labeled below the opening, the entire surface covered by a piece of glass and sealed with passe-partout tape.

Trees. Collections of the leaves, wood, and fruit of the forest trees are easily made, and will interest children because of the extensive field and variety offered. Leaves may be pressed and mounted on cardboard, fruits preserved in bottles or boxes, and the woods in cross and longitudinal section cut and dressed to show the nature and structure. An interesting and beautiful collection of all of these may be made as follows:* A frame 12x14 inches, or smaller, is made of poplar strips 1-2 inch wide by 1 or 2 inches deep with a 1-4 inch poplar back. The top and inside of the frame is hollowed out 1-4 inch the thickness of a piece of glass, and permitting a piece of glass 11 1-2x13 1-2 inches to fit in flush with the top. Suitably pressed leaves, fruit, and specimens of wood and bark are arranged on the inside of the glass (which should be fastened in place with passe-partout strips), covered with a layer of absorbent cotton filling the box tightly, and the back applied and nailed in place. The success of this manner of mounting is dependent upon having suitably prepared specimens, and upon seeing that the cotton is well packed in behind them.

Life Histories

For observing the metamorphosis of insects some sort of breeding cage is necessary. While cigar and shoe boxes may be utilized, the following box will be found to possess so many advantages that it will repay its cost, which will not exceed a dollar, in satisfaction. A frame 12 inches wide, 14 inches high, and 8 inches deep, without front or back is made of

*For this suggestion relative to mounting the editor is indebted to Professor B. G. Shackleford of the State Normal School, Cape Girardeau.

pine or poplar. One-eighth of an inch from the front and back the frame is grooved to receive a piece of glass 11 1-2 by 13 1-2 inches. A galvanized pan 2 or 3 inches high may be made to fit inside and hold soil or water. By placing this cage in the window it is possible to observe its contents at all times. For studying the life-histories of frogs and many aquatic insects it is necessary to have some kind of an aquarium. This may consist of a globe or aquarium jar, or following the directions in *Nature Study and Life* regular aquaria may be manufactured.

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